Amendments to the Drawings

The attached sheets of drawings are to introduce FIGS. 1-3. These sheets are new drawings (originally in the body of the specification).

Attachment: New Sheets

Remarks

Claims 1-7 were pending. By this amendment, no claims are cancelled. Claims 11-18 are added. Therefore, claims 1-7 and 11-18 are now pending.

Support for the claim amendments and new claims can be found throughout the specification, for example:

Claim 1: page 3, line 15 and original claim 6

Claims 11-12: page 3, lines 3-5

Claims 7, 13-14 and 18: page 3, lines 18-20

Claims 15-16: page 3, line 22

Claim 17: original claims 1 and 6-7

The specification is amended to include the complete priority information, to remove the graphs on pages 10-12 and make them FIGS. 1-3, and add figure legends.

No new matter is introduced by this amendment.

Summary of telephone interview with examiner

Applicants thank Examiner Bland and her supervisor Jiang for the courtesy of a telephone interview with Applicants' representative Sheree Lynn Rybak, Ph.D. on July 31, 2007. During this conversation, the 35 U.S.C. § 102 and 103 rejections were discussed. Applicants' representative explained that Hu *et al.* does not teach or suggest the method of amended claim 1. In addition, Applicants' representative explained that the combined teaching of Hu *et al.* and Butelman would motivate one skilled in the art to use short incubation times, not periods of time at least 4 hours. Applicants' representative also explained the unexpectedly superior results achieved by the claimed method. Although agreement was not reached, the Examiners agreed to consider these arguments carefully.

Objections to the specification

The specification was objected to because it contained graphical illustrations. The specification is amended to remove the graphs on pages 10-12. These are now shown as FIGS.

1-3. In view of these amendments, Applicants request that the objection to the specification be withdrawn.

35 U.S.C. § 102(b)

Claims 1-5 and 7 are rejected under 35 U.S.C. § 102(b) as anticipated by Hu *et al.* (*J. Food Biochem.* 23:187-96, 1999). Applicants request reconsideration.

Claim 1 is amended to recite that the reaction is incubated for at least 4 hours. As Hu *et al.* do not teach this reaction time (and instead teach reacting for 15-60 minutes, see Table 1, page 191), Hu *et al.* does not anticipate the claims, and Applicants request that the 35 U.S.C. § 102(b) rejection be withdrawn.

35 U.S.C. § 103(a)

Claim 6 is rejected under 35 U.S.C. § 103(a) as unpatentable over by Hu *et al.* (*J. Food Biochem.* 23:187-96, 1999) in view of Butelman (EP 0400346A2). Applicants disagree and request reconsideration.

It is asserted on page 5 of the Office action that it would have been obvious to one of ordinary skill in the art at the time the invention was made to employ higher temperatures in the method of Hu *et al.* However, there is no teaching or suggestion in either cited reference that higher temperatures can improve the quality of chitosan obtained.

There is no teaching or suggestion in either cited reference that longer incubation times can improve the quality of chitosan obtained; in fact the art cited teaches away from such a method. Furthermore, it is demonstrated by the current specification that the use of the claimed method produces unexpectedly higher-quality chitosan.

No teaching or suggestion that temperature can be increased to increase chitosan quality

There is no teaching or suggestion in either cited reference that higher temperatures (such as those above 125°C) can improve the quality of chitosan obtained. All of the caustic reactions performed in Hu *et al.* used to obtain the data shown in Table 1 were performed at 121°C. The only variable emphasized as important to quality of chitosan obtained is the reaction time (discussed below). It is noted on page 194 of Hu *et al.* (4th full paragraph) that at 121°C, severe degradation of chitosan was not observed. However, there is no teaching or suggestion that

further increasing the temperature could further increase the quality of chitosan obtained. Similarly, although the cited Butelman reference discloses incubation of shells from crustaceans with caustic at 150 – 200°C for short periods of time (2-15 minutes), there is no teaching or suggestion that temperature is a variable that can be altered to increase the quality of chitosan obtained.

Prior art teaches away

There is no teaching or suggestion in the cited references that reactions performed for at least 4 hours with caustic and pressures above 0 PSIG will produce a chitosan of higher quality. In fact, the cited references teach away from using longer incubation times. Hu *et al.* teach that use of longer incubation times is disadvantageous. Page 191 of Hu *et al.* state in the second full paragraph that incubations of 15 minutes resulted in the production of more chitosan, while the longer incubation period of 60 minutes "extracted the lowest amount of chitosan." Page 192 elaborates, stating:

> ...a 60 min treatment with 1M NaOH produced chitosan with the lowest molecular weight...This clearly demonstrates that time of treatment is a crucial factor to the degradation of chitosan...extraction time plays an important role in the degradation of chitosan chain...Hence, in our method, the contact time was curtailed to 15 min. (emphasis added)

In addition, page 194, 5th full paragraph states that short contact time (15 minutes) should be used to avoid severe chain degradation and deacetylation of chitosan. Therefore, Hu *et al.* teach that shorter times of incubation are desired, in order to increase the molecular weight of the resulting chitosan.

The cited Butelman reference discloses incubation of shells from crustaceans with caustic at 150 – 200°C for 2-15 minutes (see column 2, lines 31-42). This resulted in chitosan with a molecular weight of 20,000 – 100,000 and an acetyl group content of less than 5% (see column 3, lines 12-16). The disclosed incubation time of 2-15 minutes is much shorter than the at least 4 hours claimed. In addition, Butelman states in the background (column 1, lines 21-46) that obtaining chitin using 40% w/w NaOH at 100-120°C for 20-24 hours, then deacetylaing the chitin to obtain chitosan, results in chitosan that is irregular and not completely deacetylated.

Thus, Butelman teaches that use of long incubation times produces chitosan of low quality and therefore is less desirable.

Based on the combined teaching of Hu *et al.* and Butelman, one skilled in the art would not be motivated to extract chitosan from fungal biomass using longer incubation times (for example at least 4 hours). Instead, one skilled in the art would be motivated to use shorter times, as this is indicated by both cited documents to produce a chitosan that is of higher quality (e.g. higher deacetylation and higher molecular weight). Therefore, the art cited teaches away from the claimed invention.

Unexpectedly superior results

The inventors have determined that the claimed methods of treating fungal biomass with caustic at elevated pressures for long periods of time (e.g. 4 hours or more) unexpectedly produce higher-quality chitosan. As generally shown in Tables 1-3, increasing incubation time increased both percent deacetylation and purity of the resulting chitosan.

As shown in Table 1, reacting fungal biomass in 20.1% NaOH for 2-28 hours at 129-132°C resulted in chitin with a molecular weight of over 100,000, a deacetylation of 79-89%, and a purity of 43-98.4%. As shown in Table 2, reacting fungal biomass in 12.8% NaOH for 6-45 hours at 128-130°C resulted in chitin with a molecular weight of over 100,000, a deacetylation of 82-93%, and a purity of 50-98%. As shown in Table 3, reacting fungal biomass in 30.1% NaOH for 2-14 hours at 131-135°C resulted in chitin with a molecular weight of over 100,000, a deacetylation of at least 89%, and a purity of 53-94%.

Tables 4 and 5 demonstrate that without added pressure, the purity of the produced chitosan suffers, and the molecular weight of the chitosan is generally lower. However, longer incubation periods did increase chitosan purity and deacetylation.

Although the average molecular weight and molecular number of the resulting chitosan peaked after particular incubation times (depending on the particular incubation conditions), the values obtained were still significantly better than those obtained in the cited art. In addition, one skilled in the art can select the desired incubation time or other reaction conditions based on the results shown in the present application, to produce chitosan having the desired purity, percent deacetylation, and molecular weight.

Therefore, the inventors have demonstrated that the claimed invention provides unexpectedly superior quality chitosan from fungal biomass by using increased pressures and incubation times in the presence of caustic.

As there is no teaching or suggestion in either cited reference that higher temperatures can improve the quality of chitosan obtained, the cited art teaches away from the claimed invention, and because the claimed invention provides an unexpectedly superior result, Applicants submit that the 35 U.S.C. § 103(a) rejection is improper, and request that it be withdrawn.

If there are any minor issues to be resolved before a Notice of Allowance is granted, the Examiner is invited to telephone the undersigned.

Respectfully submitted,

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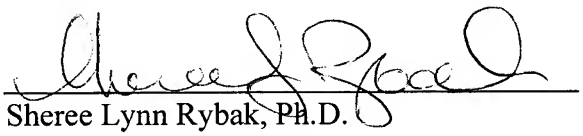
By 
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